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(12) # NEW EUROPEAN PATENT SPECIFICATION

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(54) **Vacuum circuit breaker.**

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(56) References cited :
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DE-B- 1 515 759
GB-A- 997 384
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Description

The present invention relates to a vacuum circuit breaker, and more particularly to an improvement in an electrode structure thereof adapted for magnetically driving arcs between the electrodes by its own interrupting electric current.

Brief Description of the Drawings

Fig. 1 is a vertical sectional view of one embodiment of the vacuum circuit breaker in accordance with the present invention.

Fig. 2 is a perspective view of the pair of electrodes shown in Fig. 1.

Fig. 3 is a plane view of a electrode shown in Fig. 1.

Fig. 4 is a vertical sectional view along line IV-IV of Fig. 3.

Fig.5 is a plane view of one of the prior art vacuum circuit breaker electrodes adapted for magnetically driving arcs between the electrodes.

Fig. 6 is a vertical sectional view of Fig. 5.

Background of the Invention

The vacuum circuit breaker generally comprises a vacuum casing, a pair of separable electrodes disposed in the vacuum casing in that a fixed electrode and a movable electrode facing each other and a pair of electrically conductive rods connected respectively to each electrode at their non-facing surfaces and extending respectively through the vacuum casing to the outside thereof. The other ends of the electrically conductive rods are respectively connected to an electrical source terminal and to a load terminal. Thus a current flows from the source terminal to the load terminal through the one electrically conductive rod, the pair of electrodes and the other electrically conductive rod.

Arcs are generated between the electrodes, when the movable electrode is disconnected from the fixed electrode during the circuit breaking operation.

A current interrupting capacity of a vacuum circuit breaker using simple disc shaped electrodes which form bat contact is limited, because the arcs between the electrodes stay at a local point of the electrodes and cause local heating of the electrodes, even if the diameter of the electrodes is enlarged.

For increasing the current interrupting capacity of the vacuum circuit breaker, disc shaped electrodes with a plurality of spiral grooves were proposed, wherein arcs are driven along the spiral grooves through an interaction between an arc current and a magnetic field caused by an interrupting current flowing through a current path defined by the spiral grooves so that the local stay of the arc is prevented.

Japanese patent publication No. 22634/1973 and Japanese Preliminary Publication of Patent Nos. 97061/1973 and 30174/1980 disclose the disc shaped electrodes with a plurality of spiral grooves for vacuum circuit breakers. Since the grooves of these disc shape electrodes are spiral shaped a band saw or a wire cutter was needed to form the grooves on the electrodes which was uneconomical because of a long processing time.

Recently, Japanese Preliminary Publication of Patent No. 115730/1982 proposed a disc shaped electrode with a plurality of straight grooves for a vacuum circuit breaker which are easily formed by a milling machine.

A vacuum circuit breaker according to the preamble of the claim present is known from US-A-4 210 790.

Figs. 5 and 6 show the electrode structure of above mentioned Japanese Preliminary Publication of Patent. A disc shaped electrode 40 consists of an annular contact part 41 formed around the outer circumferential portion of the disc shaped electrode and a round recessed part 42 formed on the inner portion thereof and surrounded by the annular contact part 41. Three straight grooves 43a, 43b and 43c which extend from the outer periphery of the annular contact part 41 to the round recessed part 42 are cut on the disc shaped electrode so that three contact pieces 41a, 41b and 41c are formed. Three substantionally isolated lands 44a, 44b and 44c are formed between the inner periphery of the annular contact part 41 and the straight grooves 43a, 43b and 43c.

An arc 45, for instance, generated during circuit breaking operation is driven along the circumferential direction or along the straight groove 43a shown by an arrow on the contact piece 41a by an electromagnetic force F caused by an interaction with a magnetic flux caused by a current flowing along a current path defined by the straight grooves, and some times thereafter an arc 45A is generated on the isolated land 44a, because charged particles caused by the arc 45 are apt to be trapped in the space above the isolated land 44a due to an axial component of the magnetic flux in the space. Since the direction of the arc 45A is substantially parallel to the that of the magnetic flux ϕ, the arc 45A is confined within the narrow isolated land 44a, and stays there to cause a local melting of the electrode and thus an interruption failure of the vacuum circuit breaker.

Summary of the Invention

The invention is indicated in the claim.

Description of the Preferred Embodiments

Fig. 1 illustrates one embodiment of the present invention. The vacuum circuit breaker 1 comprises an evacuated vacuum casing 2 formed of an insulating

cylinder 2a, metal fittings 3 for sealing provided on both ends of the insulating cylinder 2a, and a pair of end plates 4 attached to the metal fittings 3; a pair of conductive rods 6 extending through the respective ends plates 4 in an air tight manner; a fixed disc shaped electrode 7 connected to one of the conductive rods 6; a movable disc shaped electrode 8 facing to the fixed disc shaped electrode 7 and connected to the other conductive rod 6; bellows 9 provided between the end plate 4 and the other conductive rod 6 to permit axial movement of the movable disc shaped electrode 8 while keeping vacuum in the vacuum casing 2; and a cylindrical metallic vapor shield 5 surrounding the fixed and movable disc shaped electrodes 7 and 8 for preventing metallic vapor diffused from an arc generated between the disc shaped electrodes 7 and 8 from being deposited on the inner surface of the insulating cylinder 2. On the respective non-facing surfaces of the both disc shaped electrodes 7 and 8, elastic support plates 50 of stainless steel are provided so that the both disc shaped electrodes 7 and 8 uniformly contact each other to achieve balanced current flow throughout the contacting surface of both disc shaped electrodes 7 and 8.

Since the structures of the fixed and movable disc shaped electrodes 7 and 8 are substantially the same, the structure of the movable disc shaped electrode 8 alone is explained referring to Figs. 2, 3, and 4.

The movable disc shaped electrode 8 includes an annular contact part 10 formed around the outer circumferential portion of the disc shaped electrode 8 on the facing surface to the opposing fixed disc shaped electrode 7, and a round recessed part 11 formed on the inner portion thereof and surrounded by the annular contact part 10. The annular contact part 10 is divided into three contact pieces 13A, 13B, and 13C by three straight grooves 12A, 12B, and 12C which are cut from the outer circumferential periphery 10A of the annular contact part 10 to a boundary line 20 between the inner circumferential periphery of the annular contact part 10 and the inner round recessed part 11. As shown in Figs. 3 and 4, the straight grooves are not inclined to the axial direction, but extend in parallel to the axial direction and are cut so as to extend substantially tangentially to the boundary line 20 of the inner periphery of the annular contact part 10.

The elastic support plates 50 are also provided with three straight grooves aligned with those formed in the annular contact parts 10 of the respective disc shaped electrodes 7 and 8.

An arc generated between the fixed and movable disc shaped electrodes 7 and 8 is driven around the contact pieces 13A, 13B, and 13C passing through the grooves 12A, 12B, and 12C.

No arcing occurs again at the round recessed portion 11 near the inner periphery of the annular contact part 10, because the portion on the round recessed part 11 where an axial magnetic flux component caused by current flowing through the both electrodes prevails is eliminated and replaced by the three straight grooves 12A, 12B, and 12C.

With the vacuum circuit breaker of the present invention, the arcing at the round recessed part near the inner periphery of the annular contact part of the disc shaped electrode is prevented, thus interruption failure due to the stay of arc at the round recessed part of the disc shaped electrode is eliminated. As a result, the interrupting properties of the vacuum circuit breaker of the present invention is much improved, in that the vacuum circuit breaker with the disc shaped electrodes of 60mm diameter in accordance with the present invention interrupted 25kA at 7.2kV with great ease, on the other hand, the vacuum circuit breaker with the disc shaped electrodes shown in Figs. 5 and 6 with same diameter interrupted up to 20kA at 7.2kV.

With the vacuum circuit breaker of the present invention, the interruption failure due to the stay of the arcs is eliminated, thus the interrupting properties of the vacuum circuit breaker are much enhanced as explained.

Claims

1. A vacuum circuit breaker comprising
- a pair of separable disc-shaped electrodes (7, 8) facing to each other and disposed in a vacuum casing (2),
- the disc-shaped electrodes being separable in axial direction and are provided with a support plate (50) on the non-facing surface thereof,
- a pair of conductive rods (6) connected to each of said disc-shaped electrodes (7, 8) at their non-facing surfaces and extending through the vacuum casing (2) in air-tight manner,
- each disc-shaped electrode (7, 8) including an annular contact part (10) formed around the outer circumferential portion of the disc-shaped electrode (7) on the facing surface to the other disc-shaped electrode (8), a round recessed part (11) formed on the inner portion thereof and surrounded by the annular contact part (10) and at least three straight grooves (12A, 12B, 12C) extending in a direction parallel to the axial direction and substantially tangential to the inner periphery of the annular contact part,

characterized in
- that said grooves (12A, 12B, 12C) extend only from the outer periphery of the annular contact part (10) to the inner periphery of

the annular contact part (10),
- that the outer side walls of the grooves (12A, 12B, 12C) are positioned outside of the boundary line (20) of the inner periphery of the annular contact part (10), whereby arcing on the round recessed part (11) is prevented during circuit breaking operation of the vacuum circuit breaker and
- that the support plate (50) is elastic and provided with at least three straight grooves aligned with the straight grooves (12A, 12B, 12C) formed on the respective annular part (10).

Patentansprüche

1. Vakuumschalter mit
   - einem Paar trennbarer plattenförmiger Elektroden (7, 8), die einander gegenüberliegen und in einem Vakuumgehäuse (2) angeordnet sind,
   - wobei die plattenförmigen Elektroden in Axialrichtung trennbar sind und eine Trägerplatte (50) an deren nicht gegenüberliegenden Oberflächen aufweisen,
   - einem Paar leitender Stäbe (6), die mit jeder der plattenförmigen Elektroden (7, 8) an deren nicht gegenüberliegenden Oberflächen verbunden sind und luftdicht durch das Vakuumgehäuse (2) verlaufen,
   - wobei jede plattenförmige Elektrode (7, 8) einen ringförmigen Kontaktteil (10), welcher um den äußeren Umfangsteil der plattenförmigen Elektrode (7) auf der der anderen plattenförmigen Elektrode (8) gegenüberliegenden Oberfläche gebildet ist, einen an dessen Innenteil ausgebildeten und von dem ringförmigen Kontaktteil umgebenen runden zurückversetzten Teil (11) und mindestens drei geradlinige in einer zur Axialrichtung parallel und im wesentlichen tangential zum Innenumfang des ringförmigen Kontaktteils verlaufende Nuten (12A, 12B, 12C) aufweist,

   dadurch gekennzeichnet,
   - daß die Nuten (12A, 12B, 12C) vom Außenumfang des ringförmigen Kontaktteils (10) nur bis zum Innenumfang des ringförmigen Kontaktteils (10) verlaufen,
   - daß die äußeren Seitenwände der Nuten (12A, 12B, 12C) außerhalb der Begrenzungslinie (20) des Innenumfangs des ringförmigen Kontaktteils (10) angeordnet sind, wodurch ein Überschlag auf dem runden zurückversetzten Teil (11) während des Ausschaltvorgangs des Vakuumschalters verhindert wird, und
   - daß die Trägerplatte (50) elastisch ist und mindestens drei geradlinige Nuten aufweist, welche zu den auf dem jeweiligen ringförmigen Teil (10) ausgebildeten geradlinigen Nuten (12A, 12B, 12C) ausgerichtet sind.

Revendications

1. Disjoncteur sous vide comprenant
   - un couple d'électrodes séparables (7,8) en forme de disques, qui se font face et sont disposées dans un boîtier sous vide (2),
   - les électrodes en forme de disques étant séparables dans une direction axiale et étant équipées d'une plaque de support (50) située sur leurs surfaces qui ne sont pas en vis-à-vis,
   - un couple de barres conductrices (6) raccordées à chacune desdites électrodes en forme de disques (7,8), au niveau de leurs surfaces non en vis-àvis et s'étendant à travers le boîtier sous vide (2) d'une manière étanche à l'air,
   - chaque électrode en forme de disque (7,8) comprenant une partie de contact annulaire (10) formée autour de la partie circonférentielle extérieure de l'électrode en forme de disque (7) sur la surface en vis-à-vis de l'autre électrode en forme de disque (8), une partie en renfoncement ronde (11) formée sur la partie intérieure de celle-ci et entourée par la partie de contact annulaire (10) et au moins trois gorges rectilignes (12A,12B,12C) s'étendant dans une direction parallèle à la direction axiale et sensiblement tangentiellement à la périphérie intérieure de la partie de contact annulaire,

   caractérisé en ce
   - que lesdites gorges (12A,12B,12C) s'étendent uniquement de la périphérie extérieure de la partie de contact annulaire (10) à la périphérie intérieure de la partie de contact annulaire (10),
   - que les parois latérales extérieures des gorges (12A,12B,12C) sont disposées à l'extérieur de la ligne limite (20) de la périphérie intérieure de la partie de contact annulaire (10), de sorte que la formation d'un arc sur la partie en renfoncement ronde (11) est empêchée pendant une opération de coupure de circuit du disjoncteur sous vide, et
   - que la plaque de support (50) est élastique et comporte au moins trois gorges rectilignes alignées avec les gorges rectilignes (12A,12B,12C) ménagées dans la partie annulaire respective (10).

FIG. 1

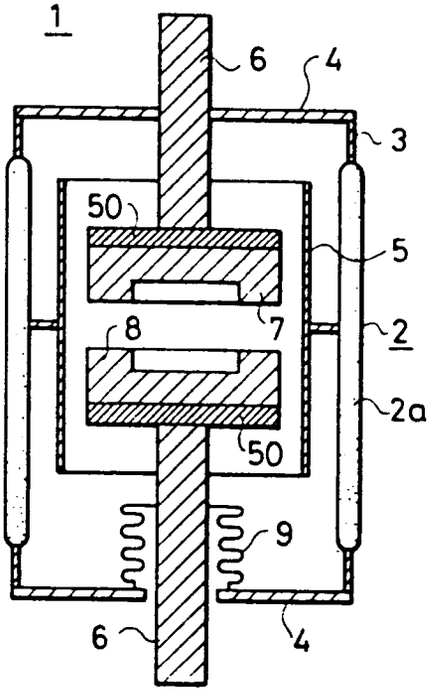

FIG. 2

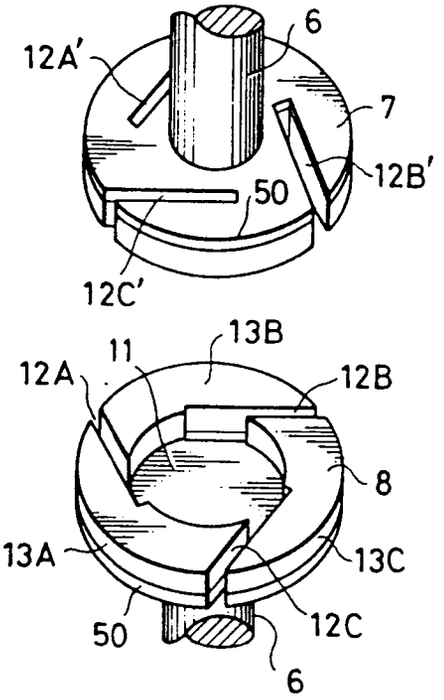

FIG. 3

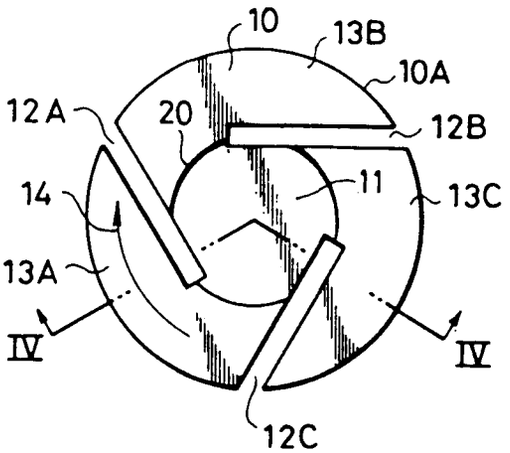

FIG. 4

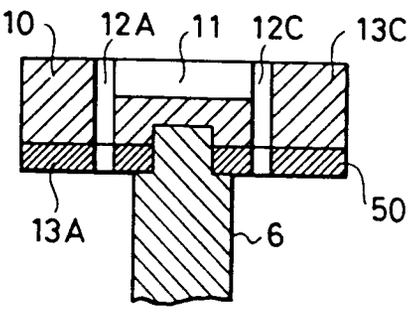

FIG. 5
PRIOR ART

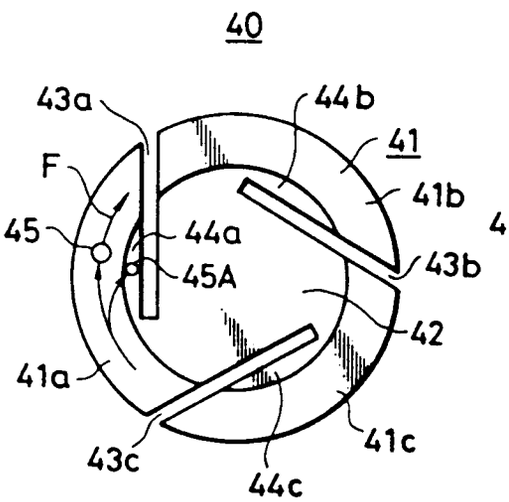

FIG. 6
PRIOR ART